U.S. ARMY

Center for Army Analysis

PRIORITIZING ARMY MILCON

DECEMBER 2001

CENTER FOR ARMY ANALYSIS
6001 GOETHALS ROAD
FORT BELVOIR, VA 22060-5230

DISCLAIMER

The findings of this report are not to be construed as an official Department of the Army position, policy, or decision unless so designated by other official documentation. Comments or suggestions should be addressed to:

Director
Center for Army Analysis
ATTN: CSCA-RA
6001 Goethals Road
Fort Belvoir, VA 22060-5230

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 2001	Final, August 2001 – December 2001

4. TITLE AND SUBTITLE
Prioritizing Army MILCON (PAM)

5. FUNDING NUMBER

6. AUTHOR(S)
LTC William J. Tarantino

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Center for Army Analysis
6001 Goethals Road
Fort Belvoir, VA 22060-5230

8. PERFORMING ORGANIZATION REPORT NUMBER
CAA-R-01-77

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Director, Center for Army Analysis
6001 Goethals Road
Fort Belvoir, VA 22060-5230

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE
A

13. ABSTRACT *(Maximum 200 Words)*

The Assistant Chief of Staff for Installation Management (ACSIM) tasked the Center for Army Analysis (CAA) to examine the military construction (MILCON) prioritization equation that ACSIM proposes to use during the next Project Review Board (PRB) and identify potential analytical improvements. A potential improvement would take the proposed equation and add a parameter or factor that would help distinguish between major Army command (MACOM) projects with like priority. Analysis and potential improvements are discussed in this report.

14. SUBJECT TERMS
MILCON, PRB, major Army command (MACOM), scaling factor, plant replacement value, Installation Status Report, MACOM priority (MP), scaling factor

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

NSN 7540-01-280-5500
Standard Form 298

(THIS PAGE INTENTIONALLY LEFT BLANK)

PRIORITIZING ARMY MILITARY CONSTRUCTION (MILCON)

SUMMARY

THE PROJECT PURPOSE is to examine the military construction (MILCON) prioritization equation that Assistant Chief of Staff for Installation Management (ACSIM) proposes to use during the next Project Review Board (PRB) and identify potential analytical improvements. A potential improvement would take the proposed equation and add a parameter or factor that would help distinguish between major Army command (MACOM) projects with like priority.

THE PROJECT SPONSOR was the Assistant Chief of Staff for Installation Management (DAIM-FDC).

THE SCOPE OF THE PROJECT. We include all MACOMs' projects for 2001. The parameters we can change include the weighting used for all MACOM priority scores, the new plant replacement value/ population (PRV/POP) parameter (P), and the overall percentage that a component contributes to the total project score. All other factors and equation components have to remain consistent with the proposed equation (in the short term).

THE MAIN ASSUMPTIONS

(1) An improvement to the current process would include a combination of the PRV and POP characteristics, because these two combined factors provide a proxy to evaluate a MACOM's property value.

(2) Even though the priority placement of all projects may seem appealing (e.g., all priority 1 be completed before priority 2 projects, etc.), we do not have a requirement to have 100 percent priority placement.

THE PRINCIPAL FINDINGS are that**:**

(1) The proposed equation can be improved (include a factor to distinguish MACOMs) with a PRV/POP factor. The P factor adds another dimension to the equation by including MACOM characteristics in their MACOM priority (MP) scores.

(2) The equation that the Air Force uses to determine their MILCON priority does not capture population impacts.

(3) A scaling factor (SF) > 6 provides the most consistent prioritization. Consistent in this sense equates to priority placement. At SF values >> 6, the difference in priority scores is so large that the other equation components are consistently overcome by this one factor.

(4) The prioritization equation does not capture all elements that influence MILCON and should be examined in detail. There are project characteristics that the current equations do not address. The long-term effort should identify these characteristics and possibly include them in a decision support system (DSS) for ACSIM (long-term project with the Naval Postgraduate School (NPS)).

THE PRINCIPAL RECOMMENDATIONS are:

(1) In the short term:

- Add a P factor to the notional scheme.
- Use the following equation: **Project score = C + (1+P)*SF * (1-MACOM Priority) + ISR + PRB + IPT.**
- Use the following components: **Installation Status Report (ISR) - High, PRB – Low, MACOM Team Assessment (IPT) – Low.**

(2) Long-term effort:

- Develop a decision support system that will assist ACSIM in examining priorities and developing the Army's MILCON priority list. Include costs, MILCON project status, budget constraints, and other project characteristics as developed by the student and approved by ACSIM.
- Sponsor an NPS graduate student to complete the project (CAA will assist, monitor, and provide required support; Dr. Rob Dell will be the student's advisor). Project is ongoing, with an expected completion date of June 2002.

THE PROJECT EFFORT was conducted by LTC William Tarantino, Resource Analysis Division, Center for Army Analysis (CAA).

COMMENTS AND QUESTIONS may be sent to the Director, Center for Army Analysis, ATTN: CSCA-RA, 6001 Goethals Road, Suite 102, Fort Belvoir, VA 22060-5230

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 Purpose

The project purpose is to examine the military construction (MILCON) prioritization equation that Assistant Chief of Staff for Installation Management (ACSIM) proposes to use during the next Project Review Board (PRB) and identify potential analytical improvements. A potential improvement would take the proposed equation and add a parameter or factor that would help distinguish between major Army command (MACOM) projects with like priority.

1.2 Background

The current prioritization process uses the PRB to complete the priority placement for Army MILCON projects. The PRB consists of a construction requirements review committee that determines if a project must be funded in the program year or deferred to future years. The PRB assigns points to a project based on its overall merit. During the PRB, the Construction Requirements Review Committee determine a relative placement of a project using the following five-point scale:

5 – absolutely needs, CY+2 if possible

4 – do project CY+3

3 – do project CY+3, if funds are available

2 – valid project but can wait

1 – not a valid project

The proposed process would combine the MACOM's priority (MP) assessment of their projects with the PRB evaluation, the MILCON Team Assessment (IPT), and the Installation Status Report (ISR) to develop one combined project score, which can be used to prioritize projects. The IPT scores are determined using the following matrix:

Table 1. IPT

Efficiencies	Return on investment – savings/cost avoidance Consolidate/collocate functions Demonstrated joint use potential On-base/off-base consolidations	1.00 pts
Mission timing	Precludes workarounds – leasing, temporary facilities Supports synchronized arrival of new mission Project phasing plans are sound	1.00 pts
Design build	Project will use design build procurement process	1.00 pts
Demolition – facilities reduction	Demolishes 100 percent of scope of new build Eliminates relocatables, leases, or temporary facilities = 100 percent of new build	0.75 pts
Demolition – limited growth	Demolishes 50 percent of scope of new build Eliminates relocatables, leases, or temporary facilities = 50 percent of new build	0.25 pts
Sustainable design	Sustainable design components are an integral part of project design	1.00 pts

The ISR evaluation is summarized below.

Table 2. ISR

Facility type / ISR	support	Mobility	Housing	Community	Installation support
C-4	20	19.5	19	18.5	18
C-3	17.5	17	16.5	16	15.5
C-2	15	14.5	14	13.5	13
C-1	12.5	12	11.5	11	10.5

1.3 Objectives

Short Term

ACSIM tasked the Center for Army Analysis (CAA) to assist them in meeting their short-term goal of strengthening the process equation by adding an objective parameter in the equation that helps to distinguish across MACOMs and their projects.

To meet the ACSIM's short-term objective, we are limited to changing the weighting of priorities in the process equation and adding a factor that represents the plant replacement value (PRV) and/or the MACOM's population (POP) to the equation (PRV and POP factor ~ P factor). These two factors represent a proxy for the value of a MACOM's project relative to the other MACOMs. The PRV is the value of the installation's facilities and infrastructure and represents an estimate of what it would cost to rebuild or replace the MACOM's properties; the population represents the MACOM's soldiers and all supporting personnel that the MACOM serves.

Long Term

In the long term, ACSIM would prefer a decision support system that would provide a capability to look at the MILCON prioritization problem optimally, which may include additional factors (i.e., cost).

CAA is sponsoring a Naval Postgraduate School student, who will develop an optimization-based decision support system to develop Army MILCON priorities. The student will present his research in a master's thesis for implementation at ACSIM.

1.4 Key Assumptions and Limitations

Key Assumptions

The study's primary assumption is that the combination of the PRV and POP characteristics provides a reasonable proxy to help distinguish between MACOMs and thus between their projects.

We also assume that even though the priority placement of all projects may seem appealing to some (e.g., all priority 1 be completed before priority 2 projects, etc.), we do not

have a requirement to have 100 percent priority placement. There are cases when lower priority projects from one MACOM are a higher priority than other higher rated projects from other MACOMs from the Army perspective. In some cases, this difference in priority is easily explained. For example, if we consider the Installation Status Report (good condition ~ C-1, poor condition ~ C-4) we may have one MACOM with a priority 1 project that is "C-1" while another MACOM has a priority 1 project that is "C-4." It would make sense if the ACSIM placed the C-4 in front of the C-1 project because he is balancing the prioritization for the Army (not for a MACOM) and has to cross-level all projects as opposed to the MACOMs who are only concerned with prioritizing their own projects.

Limitation

The project's primary limitation is that in the short term, we cannot affect other shortcomings in the proposed equation. For example, cost, schedule, and other aspects of a project should be considered in any final DSS. A second shortcoming is the inability to capture all of the factors that the ACSIM feels are important to his overall prioritization in the proposed equation's framework. These factors will also be addressed in the long-term project.

1.5 Scope

We are including all MACOMs' projects for 2001. The parameters we can change include the Scaling Factor (SF), the constant (C) that is added to all MACOM priority scores, the new plant replacement value/population (PRV/POP) parameter (P), and the overall percentage that a component contributes to the total project score. All other factors and equation components have to remain consistent with the proposed equation (in the short term).

(THIS PAGE INTENTIONALLY LEFT BLANK0

2 METHODOLOGY

The methodology we used to develop the final equation is based on data analysis and simulation to examine all the equation components and their interactions. When we examine the possible equations, we consider:

- The dispersion between priorities,
- The values of the scores and if the scores are negative,
- The performance of the equation, i.e., how well the equation's solution can be explained by inputs, and
- The relationships between the different components.

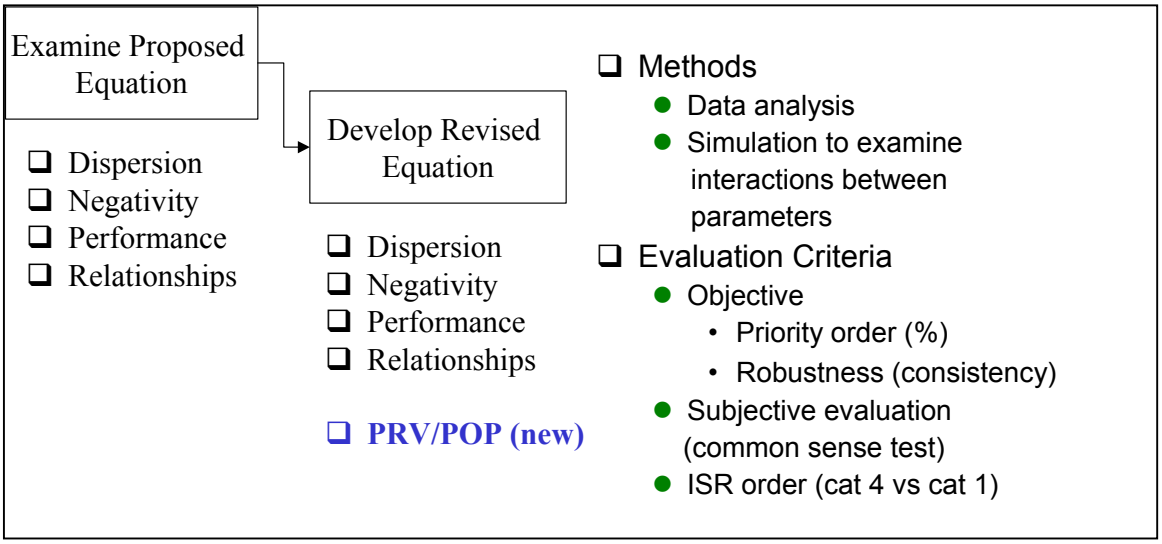


Figure 1. Methodology

We evaluate the equations using objective and subjective metrics.

Objective – the priority placement of all projects as a percentage of all projects in priority order as well as the robustness or consistency of a project's placement within the context of all projects, due to a change in a component's value.

Subjective – We look at the project listing and make a judgment call on the quality of the solution. For example, does the ISR impact on priority placement make sense.

2.1 Proposed Prioritization Equation

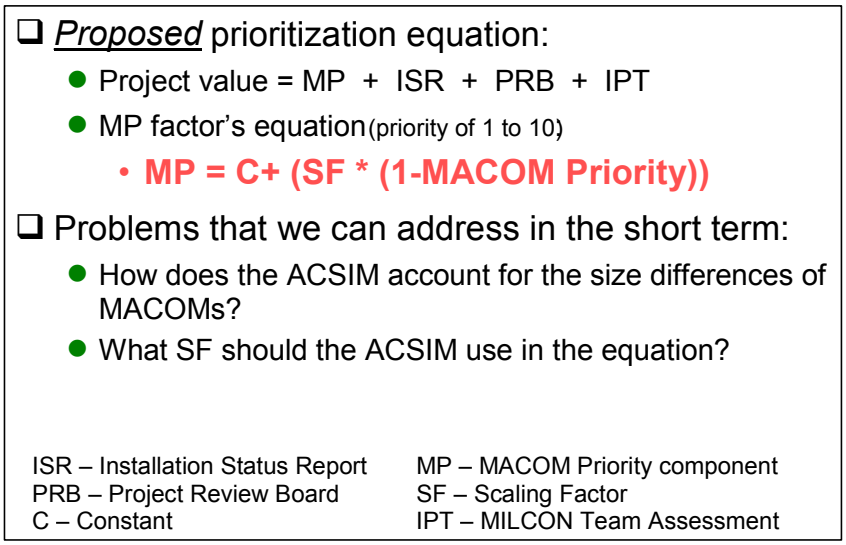


Figure 2. Proposed Prioritization Equation

The proposed prioritization equation includes the four components in Figure 2.

The MP component of this equation is the area of interest. MP represents the scalar C and the scaled MACOM priority score. C has little value in the equation since it is simply a constant added to all scores, but the C value does place the overall score into a range of values that is easily understood. For example, scores that range from 0 to 100 are probably more understandable to most people reviewing the scores than a score ranging from –40 to 30.

The second part of the MP component includes the SF and the MACOM priority. The maximum value of this component equals zero when the MACOM project has a priority of "1". The component value decreases by the value of SF for each corresponding decrease in MACOM priority.

In the short term we can look at the SF and determine what value seems to make sense, i.e., maintain relative prioritization between projects. We can also add a factor to this component that accounts for the differences in the MACOM's size in terms of PRV and POP.

2.2 Parameters

The following table provides a synopsis of the model parameters and components.

1. MACOM Priority: an input from the MACOMs; ranges from 1 to 10.
2. Constant: the maximum number of points that a MACOM project can be awarded for their priority part of a project's score. If a project is priority "1," then the project is awarded C. For all other priorities, the C is degraded. The simulation allowed the C score to range from 50 to 80 points, which equated to a range from –40 to 80 possible points for a MACOM priority of 10 and 1, respectively.

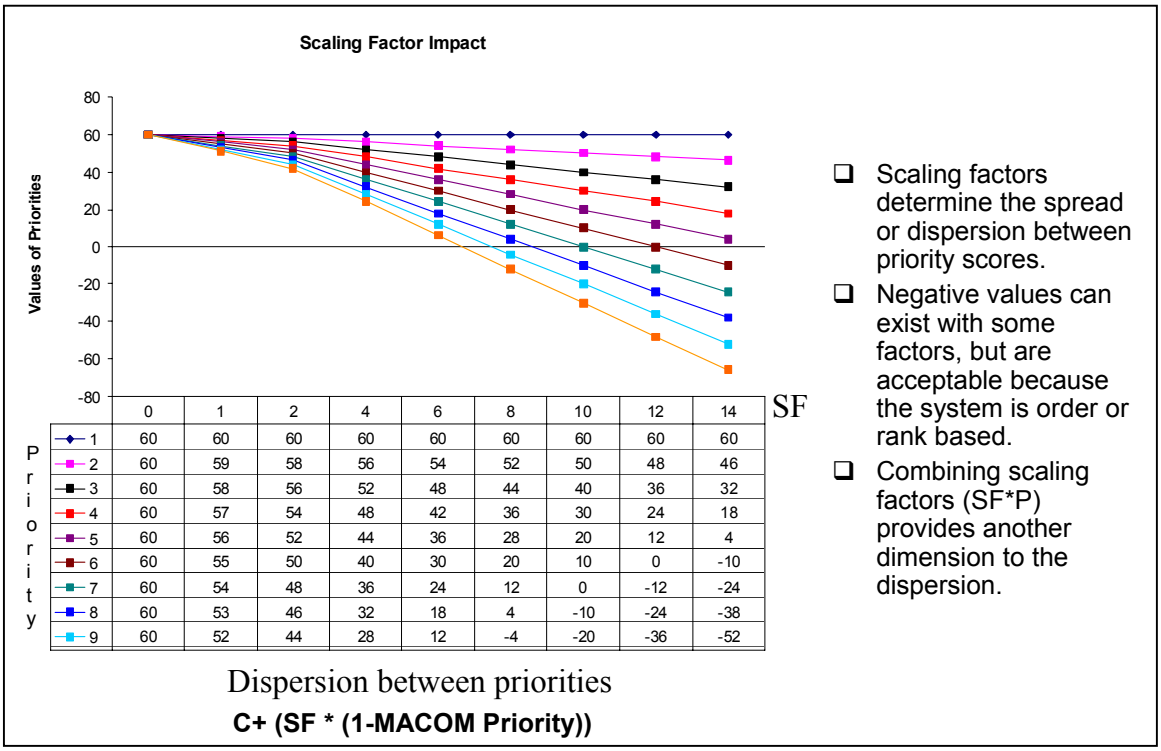
3. MILCON Priority: The MP is a calculated value that depends on C, the MACOM priority, and SF. Based on the ranges for those factors, the limits on MP are 80 to –40.
4. Installation Status Report: the status of the infrastructure that the new project will replace. Actual values range from 10.5 to 20 points (cat 1 is 10.5, cat 4 is 20), but in the simulations the value ranged from 5.25 to 20 points.
5. Project Review Board: the results of a yearly board that looks at all projects and evaluates them in terms of the necessity of the project (absolute need to invalid project). PRB ranges from 1 to 5 and 1 to 15 in the simulation.
6. MILCON Team Assessment: the IPT score is a combination of project efficiencies, timing, design, facility reduction program, and sustainability. The values range from 1 to 5.
7. Scaling Factor: a factor that determines the spread between priorities in the priority portion of the notional equation. This value can range from 1 to 10 and is explained later in more detail.

Table 3. Parameters

Component	Symbol	Min	Max
MACOM Priority		1	10
Constant	C	50	80
MILCON Priority	MP	-40	80
Installation Status Report	ISR	10.5 (5.25-10.5)	20 (10-20)
Project Review Board	PRB	1	15
MILCON Team Assessment	IPT	0	5
Scaling Factor	SF	1	10
PRV--POP (new)	P	0+P	2+P

2.3 Scaling Factor's Purpose

SF provides a level of dispersion between projects of different priorities. As Figure 3 illustrates, when the SF increases, the dispersion between priorities increases by the value of SF. For example, if SF = 6 and a project has a priority of 3, then this component's value is 48. A priority 4 project receives a score of 42, a 6-point difference. Negative values can result if SF is greater than 6 for priority values 6 to 10, but this is simply an ordering of the projects and should not be considered unacceptable.



Priority \ SF	0	1	2	4	6	8	10	12	14
1	60	60	60	60	60	60	60	60	60
2	60	59	58	56	54	52	50	48	46
3	60	58	56	52	48	44	40	36	32
4	60	57	54	48	42	36	30	24	18
5	60	56	52	44	36	28	20	12	4
6	60	55	50	40	30	20	10	0	-10
7	60	54	48	36	24	12	0	-12	-24
8	60	53	46	32	18	4	-10	-24	-38
9	60	52	44	28	12	-4	-20	-36	-52

Figure 3. Scaling Factor's Purpose

The introduction of a second parameter in this equation will change the relationship in Figure 3 based on the size of the MACOM that owns the project. For example, if the MACOM weighting factor is multiplicative (i.e., SF x P) and P is equal to 1, then the relationship would mimic Figure 3 but a second MACOM with a factor of .5 would have a higher value for the same priority/SF combination. This factor would decrease the impact of the SF and thus increase the component's overall value. Using this technique, two projects with the same priority, but from different MACOMs, will have different values, which are based on the MACOM PRV and POP characteristics.

3 PROPOSED PROCESS EXAMPLE

Figure 4 provides a listing of MACOM projects the MACOM Priority for each project, and the overall project score with a SF = 7. We see that most projects (50 out of 64) are in increasing order of priority placement (i.e., priority 1 before 2, before 3, etc.).

The darker shaded "No" values represent a place in the overall listing where a project with a lower priority is placed before a higher priority project. This can happen because the prioritization is made up of four components and the MP is only one consideration. A higher ISR, PRB, or IPT score can overcome the MP component's value.

		OK	50				
		NO	14				
MACOM	MP	SF=7	78%		MP	SF=7	
INSCOM	1	95.3	OK	INSCOM	3	79.1	OK
TRADOC	1	93.6	OK	USAREUR	3	79.1	OK
USARPAC	1	93.4	OK	MEDCOM	3	76.8	OK
EUSA	1	92.1	OK	FORSCOM	3	76.7	OK
USARPAC	1	91.9	OK	ATEC	2	76.0	NO
MDW	1	90.9	OK	USARPAC	3	75.2	OK
CIDC	1	90.3	OK	EUSA	4	74.7	OK
USMA	1	90.3	OK	MDW	3	73.9	NO
FORSCOM	1	89.8	OK	ATEC	3	73.4	NO
MEDCOM	1	89.7	OK	USAREUR	4	72.8	OK
AMC	1	88.9	OK	FORSCOM	4	72.7	OK
USAREC	1	88.7	OK	AMC	3	70.4	NO
TRADOC	2	87.1	OK	USARPAC	4	70.2	OK
FORSCOM	2	87.1	OK	MDW	4	68.1	OK
ATEC	1	86.6	NO	AMC	4	66.9	OK
EUSA	2	86.3	OK	TRADOC	4	66.2	OK
DAR	1	85.8	NO	USAREUR	5	65.9	OK
INSCOM	2	85.7	OK	AMC	5	62.9	OK
MEPCOM	2	85.3	OK	USAREUR	6	61.1	OK
CIDC	2	84.8	OK	USARPAC	5	60.7	NO
MTMC	1	84.1	NO	FORSCOM	6	60.0	OK
MEPCOM	1	83.4	NO	FORSCOM	5	59.3	NO
USAREUR	1	83.3	NO	MDW	5	58.9	NO
USMA	2	82.8	OK	AMC	6	58.1	OK
USARPAC	2	82.7	OK	USARPAC	6	56.9	OK
MEDCOM	2	82.6	OK	FORSCOM	7	53.6	OK
USAREUR	2	82.4	OK	AMC	7	52.3	OK
USAREC	2	82.3	OK	USARPAC	7	50.9	OK
MDW	2	81.7	OK	FORSCOM	8	47.8	OK
EUSA	3	81.5	OK	FORSCOM	9	41.5	OK
TRADOC	3	80.8	OK	USARPAC	8	40.9	NO
AMC	2	79.8	NO	FORSCOM	10	38.5	OK

- With a SF =7 and the current equation, 78% of all projects are within priority placement.
- Projects within a priority level are not influenced by MACOM characteristics (PRV or Population not in equation).

Figure 4. Proposed Process Example

There is no reason to believe that 100 percent increasing priority placement would be better than the above result; in fact, that is probably not the case. If it were the case, the ACSIM could simply change the equation to one component, the MP, and then arrange projects based on MACOM inputs. The equation needs to address issues across MACOMs, and for that reason it needs these other components to account for Army priorities as well as balance MACOM requirements.

We can, however, improve the selection process by adding the PRV/POP factor to the MP. This would somewhat adjust the above results to account for MACOM size characteristics. The

balance we need to consider is the weight given the MP factor versus the other components, because too high a weight will in effect negate the impact or value of the other components.

3.1 Revised Prioritization Process

The revised equation is the ACSIM's proposed equation with one new factor, which we call "P" to represent the PRV and POP of the MACOM. We explore a multiplicative relationship in the MP component and leave all other components as is. The larger MACOMs should have lower values for this P factor.

We examine the Air Force (AF) approach to the prioritization, which also uses a similar PRV adjustment factor. We feel the AF approach is an improvement over past Army equations; however, an improved measure of the value of each project would include the PRV ***and*** the MACOM's population. If we apply only one of the two measures in the equation, then MACOMs with one large (PRV or POP) value would be favored. We describe the PRV POP relationship in the next section.

- *Option 1: Revised* prioritization equation:
  - Same as ACSIM's proposed equation with possibly different % of totals
  - MP component equation with new scaling factor P:
    - **MP = C + (1+P)*SF * (1-MACOM Priority)**
- *Option 2:* Consider Air Force equation
  - $$\text{Project Value} = \left[C + \frac{SF * (1\text{-MACOM Priority}) * .01}{\%\ PRV} \right]$$

PRV – Plant Replacement Value
ISR – Installation Status Report
PRB – Project Review Board
MP – MACOM Priority Component
SF – Scaling Factor

Figure 5. Revised Prioritization Process

3.2 PRV and POP Factors

The PRV provides an emphasis for MACOM projects with higher investments in their installations. The population factor provides emphasis to the MACOM that has the largest concentration of Army forces and civilian personnel (ACSIM provided all data).

Figure 6 provides the PRV and POP figures for all MACOMs as well as their rank in relation to other MACOMs. For example, AMC has the highest PRV (rank 18) while FORSCOM has the largest POP (rank 18).

- PRV provides emphasis to the MACOMs with larger installation investments.
- POP provides emphasis to the MACOMs with the most Army population.

	Plant Relpacement Value			Population		
MACOM	PRV ($)	% total PRV	Rank	Pop Served	% Total POP	Rank
AMC	45,019,786,349	29.48	18	103,306	10.17	15
FORSCOM	31,828,245,059	20.84	17	270,426	26.61	18
TRADOC	29,559,825,475	19.36	16	248,332	24.44	17
USARPAC	13,347,205,223	8.74	15	49,328	4.85	12
USAREUR	8,255,020,391	5.41	14	121,397	11.95	16
EUSA	5,411,648,299	3.54	13	57,054	5.61	13
MDW	4,375,997,571	2.87	12	65,302	6.43	14
ATEC	4,114,789,455	2.69	11	9,174	0.90	7
MTMC	2,183,726,910	1.43	10	1,243	0.12	1
USARSO	2,111,087,976	1.38	9	5,826	0.57	5
USMA	1,894,765,486	1.24	8	10,960	1.08	9
SMDC	1,890,018,483	1.24	7	3,236	0.32	4
MEDCOM	1,553,923,776	1.02	6	32,663	3.21	11
INSCOM	770,747,585	0.50	5	9,051	0.89	6
USACE	240,034,373	0.16	4	15,049	1.48	10
CIDC	95,421,690	0.06	3	1,541	0.15	2
USAREC	22,807,364	0.01	2	10,115	1.00	8
MEPCOM	17,312,990	0.01	1	2,111	0.21	3
Total:	152,692,364,455			Total: 1016114		

(On this chart 18 is largest)

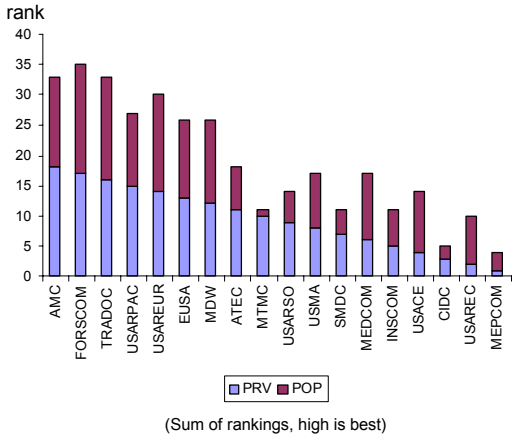


Figure 6. PRV and Population

The graphic in Figure 6 has the MACOMs listed in decreasing order of PRV rank (lightly shaded). We see when we add the POP rank (dark shade) to the PRV that the largest MACOMs in terms of PRV have relatively larger POP ranks, but not consistently or in decreasing order of PRV (using rank provides a dimensionless number that accounts for MACOM characteristics). This relationship shows that by including the POP factor, one would derive a different priority for projects than just with PRV.

3.3 Proposed P Factor

The proposed P factor is simply the average of a MACOM's PRV + POP ranks as a percentage of the sum of averages over all MACOMs. For example, AMC has the highest PRV (rank 1) and the fourth highest POP (rank 4) for an average rank of (1+4)/2 = 2.5/171 = 1.46 percent of the 171 possible points.

	Plant Replacement Value		Population		Ranking			
MACOM	PRV ($)	% total PRV	Pop Served	% Total POP	PRV	POP	AVG (P+P)	% of Total
FORSCOM	31,828,245,059	20.84	270,426	26.61	2.0	1.0	1.5	0.88%
AMC	45,019,786,349	29.48	103,306	10.17	1.0	4.0	2.5	1.46%
TRADOC	29,559,825,475	19.36	248,332	24.44	3.0	2.0	2.5	1.46%
USAREUR	8,255,020,391	5.41	121,397	11.95	5.0	3.0	4.0	2.34%
USARPAC	13,347,205,223	8.74	49,328	4.85	4.0	7.0	5.5	3.22%
EUSA	5,411,648,299	3.54	57,054	5.61	6.0	6.0	6.0	3.51%
MDW	4,375,997,571	2.87	65,302	6.43	7.0	5.0	6.0	3.51%
ATEC	4,114,789,455	2.69	9,174	0.90	8.0	12.0	10.0	5.85%
USMA	1,894,765,486	1.24	10,960	1.08	11.0	10.0	10.5	6.14%
MEDCOM	1,553,923,776	1.02	32,663	3.21	13.0	8.0	10.5	6.14%
USARSO	2,111,087,976	1.38	5,826	0.57	10.0	14.0	12.0	7.02%
USACE	240,034,373	0.16	15,049	1.48	15.0	9.0	12.0	7.02%
MTMC	2,183,726,910	1.43	1,243	0.12	9.0	18.0	13.5	7.89%
SMDC	1,890,018,483	1.24	3,236	0.32	12.0	15.0	13.5	7.89%
INSCOM	770,747,585	0.50	9,051	0.89	14.0	13.0	13.5	7.89%
USAREC	22,807,364	0.01	10,115	1.00	17.0	11.0	14.0	8.19%
CIDC	95,421,690	0.06	1,541	0.15	16.0	17.0	16.5	9.65%
MEPCOM	17,312,990	0.01	2,111	0.21	18.0	16.0	17.0	9.94%
Total	**152,692,364,455**		**1016114**				**171.0**	**100.0%**

❑ P factor = % of Total = $$\frac{(PRV_{MACOM} + POP_{MACOM})/2}{\sum_{MACOMS} Average}$$

Figure 7. Proposed P Factor

There is a tradeoff made between the MP and other components (MP = C + (1+P)*SF*(1 – MACOM Priority)). By providing a percentage value instead of the raw value, we decrease the overall impact of the P factor, but if we used the raw value, we would significantly increase the MP influence and lessen the role or import of the other components (normalization process).

3.4 Alternative Equations and Results

The initial ACSIM equation gives all projects with the same priority the same MP value. For example, with an SF of 7 and a priority of 2, then all projects have a MP component value of 53 = (60-7*(1-2)) or (C-SF(1-MACOM Priority)). This approach does not take into account the differences in MACOM PRV or POP characteristics.

Using the Air Force approach (AF in Figure 8), we see the scores are different in the MP component values, but with a few exceptions, this difference is very small.

The revised equation generally increases this difference within a priority and across priorities. An even larger difference could be applied if desired by using raw PRV/POP ranks or other factors. If the MP ranking is similar for two projects, then the project's overall placement will be determined by the equation's other components (ISR, IPT, PRB) similar to the current procedures.

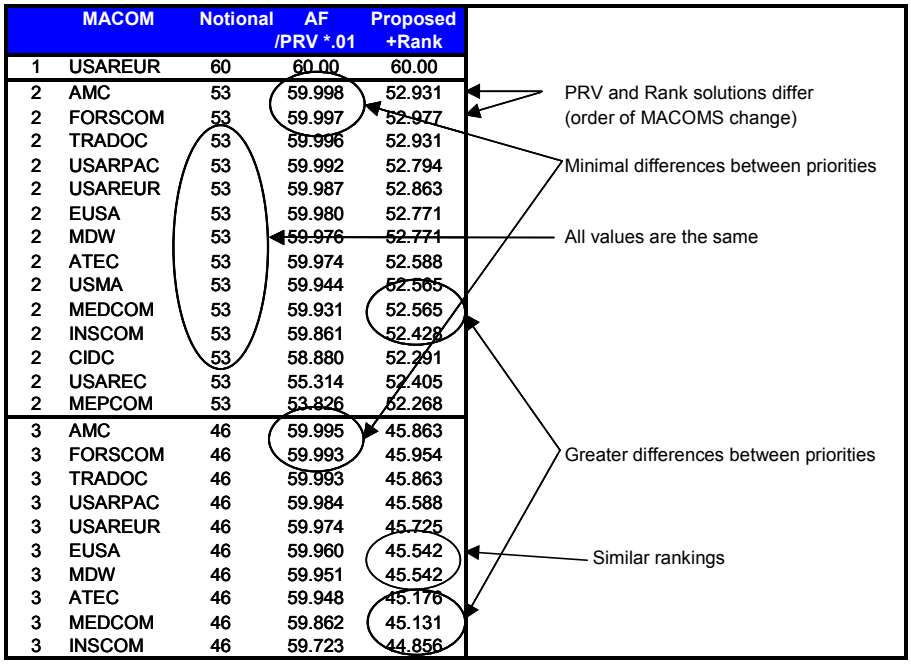


Figure 8. Alternatives Equations and Results

(THIS PAGE INTENTIONALLY LEFT BLANK)

4 SIMULATION ANALYSIS

The different parameters in the model influence the prioritization order in several ways. We can examine these impacts through a data analysis using simulations. This data analysis provides an overview of the equation and how the components interact.

An interactive spreadsheet provides the analyst a way to examine different parameters and components and the impact on a project's placement. The sheet is designed to allow an analyst to see why a project is placed in the order that the equation places it and the impact of different components. Of course, the prioritization equation, just like the spreadsheet, should be considered a proposed solution. There are always factors that could force the adjustment of the proposed priority order for which the equation does not account. Such considerations could be added to the spreadsheet.

We completed a data analysis to examine the influential parameters in the equation. The data analysis results illustrate that different SF factors have an influence on the overall priority placement. Each SF provides a different level of dispersion between priorities, which in effect, provides the difference between the amounts of all other components for two projects, a smaller dispersion enables a lower priority project to be higher on the final project list. For example, with an SF of 3, a priority project 1 has an MP of 60, and priority 2 has an MP of 57. This being the case, a project with a priority of 2 could be placed higher than a priority 1 project if the sum of all other components differs by a value of 3 or greater in favor of the priority 2 project. With an SF of 7, this value increases to 7 and thus fewer projects would be out of priority order. This result illustrates how the lower SF in effect increases the other components' level of influence.

The most influential factor, beside the SF, is the weighting on P. This was an expected result. Adding a constant >1 has the effect of increasing the P factor and thus increasing the dispersion between projects of differing priorities.

The P factor does have an influence when projects have similar priorities. In other words, if all components are approximately the same and two projects have the same MP, then the larger MACOM will be placed higher on the priority list. The P we use is relatively small compared to other components and can therefore be overcome by a larger difference in other component scores. The P factor can be adjusted to give MP a higher level of import.

The PRB and IPT have little impact mainly due to their lower values, but the ISR rating does have an influence due to the large possible difference in project values (20 for Condition 4 and 10.5 for Condition 1). This equation characteristic makes sense, since the project's condition (higher ISR score) should be a possible reason for placing a low project before a higher priority project.

4.1 New Process Example

Figure 9 has an example of the proposed (first and third columns) and the revised (second and fourth columns) equation with the projects MP score (Pri PTS) and the overall project score (total points).

The shaded "No" values represent a place in the overall listing where a project with a lower priority is placed before a higher priority project (this is not implied to be a bad condition, it is simply a reference).

Proposed					Revised					Proposed					Revised				
MACOM	Pri		Pri PTS	Total Points	MACOM	Pri		Pri PTS	Total Points	MACOM	Pri		Pri PTS	Total Points	MACOM	Pri		Pri PTS	Total Points
INSCOM	1	OK	60.00	95.25	INSCOM	1	OK	60.00	95.25	INSCOM	3	OK	46.00	77.09	USAREUR	3	OK	45.73	76.81
TRADOC	1	OK	60.00	93.60	TRADOC	1	OK	60.00	93.60	USAREUR	3	OK	46.00	77.08	INSCOM	3	OK	44.86	75.94
USARPAC	1	OK	60.00	93.37	USARPAC	1	OK	60.00	93.37	ATEC	2	NO	53.00	75.02	FORSCOM	3	OK	45.95	74.61
EUSA	1	OK	60.00	92.08	EUSA	1	OK	60.00	92.08	MEDCOM	3	OK	46.00	74.77	ATEC	2	NO	52.59	74.61
USARPAC	1	OK	60.00	91.91	USARPAC	1	OK	60.00	91.91	FORSCOM	3	OK	46.00	74.66	MEDCOM	3	OK	45.13	73.90
MDW	1	OK	60.00	90.93	MDW	1	OK	60.00	90.93	USARPAC	3	OK	46.00	73.18	USARPAC	3	OK	45.59	72.77
CIDC	1	OK	60.00	90.34	CIDC	1	OK	60.00	90.34	MDW	3	OK	46.00	71.91	MDW	3	OK	45.54	71.45
USMA	1	OK	60.00	90.34	USMA	1	OK	60.00	90.34	EUSA	4	OK	39.00	71.67	EUSA	4	OK	38.31	70.99
FORSCOM	1	OK	60.00	89.84	FORSCOM	1	OK	60.00	89.84	ATEC	3	NO	46.00	71.42	ATEC	3	NO	45.18	70.60
MEDCOM	1	OK	60.00	89.68	MEDCOM	1	OK	60.00	89.68	USAREUR	4	OK	39.00	69.76	FORSCOM	4	OK	38.93	69.61
AMC	1	OK	60.00	88.86	AMC	1	OK	60.00	88.86	FORSCOM	4	OK	39.00	69.68	USAREUR	4	OK	38.59	69.34
USAREC	1	OK	60.00	88.66	USAREC	1	OK	60.00	88.66	AMC	3	NO	46.00	68.36	AMC	3	NO	45.86	68.22
ATEC	1	OK	60.00	86.58	ATEC	1	OK	60.00	86.58	USARPAC	4	OK	39.00	67.16	USARPAC	4	OK	38.38	66.54
TRADOC	2	OK	53.00	86.09	FORSCOM	2	OK	52.98	86.04	MDW	4	OK	39.00	65.14	MDW	4	OK	38.31	64.45
FORSCOM	2	OK	53.00	86.06	TRADOC	2	OK	52.93	86.02	AMC	4	OK	39.00	63.91	AMC	4	OK	38.79	63.70
DAR	1	NO	60.00	85.84	DAR	1	NO	60.00	85.84	TRADOC	4	OK	39.00	63.18	TRADOC	4	OK	38.79	62.98
EUSA	2	OK	53.00	85.26	EUSA	2	OK	52.77	85.03	USAREUR	5	OK	32.00	61.85	USAREUR	5	OK	31.45	61.30
INSCOM	2	OK	53.00	84.68	INSCOM	2	OK	52.43	84.11	AMC	5	OK	32.00	58.92	AMC	5	OK	31.73	58.65
MEPCOM	2	OK	53.00	84.33	MTMC	1	NO	60.00	84.08	USARPAC	5	OK	32.00	56.67	USARPAC	5	OK	31.18	55.84
MTMC	1	NO	60.00	84.08	MEPCOM	2	OK	52.27	83.59	USAREUR	6	OK	25.00	56.14	USAREUR	6	OK	24.31	55.45
CIDC	2	OK	53.00	83.84	MEPCOM	1	NO	60.00	83.41	FORSCOM	5	NO	32.00	55.32	FORSCOM	5	NO	31.91	55.23
MEPCOM	1	NO	60.00	83.41	USAREUR	1	NO	60.00	83.26	FORSCOM	6	OK	25.00	55.00	FORSCOM	6	OK	24.89	54.88
USAREUR	1	NO	60.00	83.26	CIDC	2	OK	52.29	83.13	MDW	5	NO	32.00	54.89	MDW	5	NO	31.08	53.97
USMA	2	OK	53.00	81.84	USARPAC	2	OK	52.79	81.47	AMC	6	OK	25.00	53.07	AMC	6	OK	24.66	52.73
USARPAC	2	OK	53.00	81.68	USMA	2	OK	52.57	81.40	USARPAC	6	OK	25.00	51.90	USARPAC	6	OK	23.97	50.87
MEDCOM	2	OK	53.00	81.61	USAREUR	2	OK	52.86	81.29	FORSCOM	7	OK	18.00	47.57	FORSCOM	7	OK	17.86	47.43
USAREUR	2	OK	53.00	81.42	MEDCOM	2	OK	52.57	81.17	AMC	7	OK	18.00	46.30	AMC	7	OK	17.59	45.89
USAREC	2	OK	53.00	81.25	USAREC	2	OK	52.41	80.66	USARPAC	7	OK	18.00	44.92	USARPAC	7	OK	16.76	43.68
MDW	2	OK	53.00	80.68	MDW	2	OK	52.77	80.45	FORSCOM	8	OK	11.00	40.76	FORSCOM	8	OK	10.84	40.60
EUSA	3	OK	46.00	79.49	EUSA	3	OK	45.54	79.03	USARPAC	8	OK	11.00	33.86	FORSCOM	9	OK	3.82	33.31
AMC	2	NO	53.00	78.77	AMC	2	NO	52.93	78.70	FORSCOM	9	OK	4.00	33.50	USARPAC	8	NO	9.56	32.42
TRADOC	3	OK	46.00	78.76	TRADOC	3	OK	45.86	78.63	FORSCOM	10	OK	-3.00	29.52	FORSCOM	10	OK	-3.21	29.31

NO -- project is not in priority placement
MACOM -- Project placement changed with revised equation

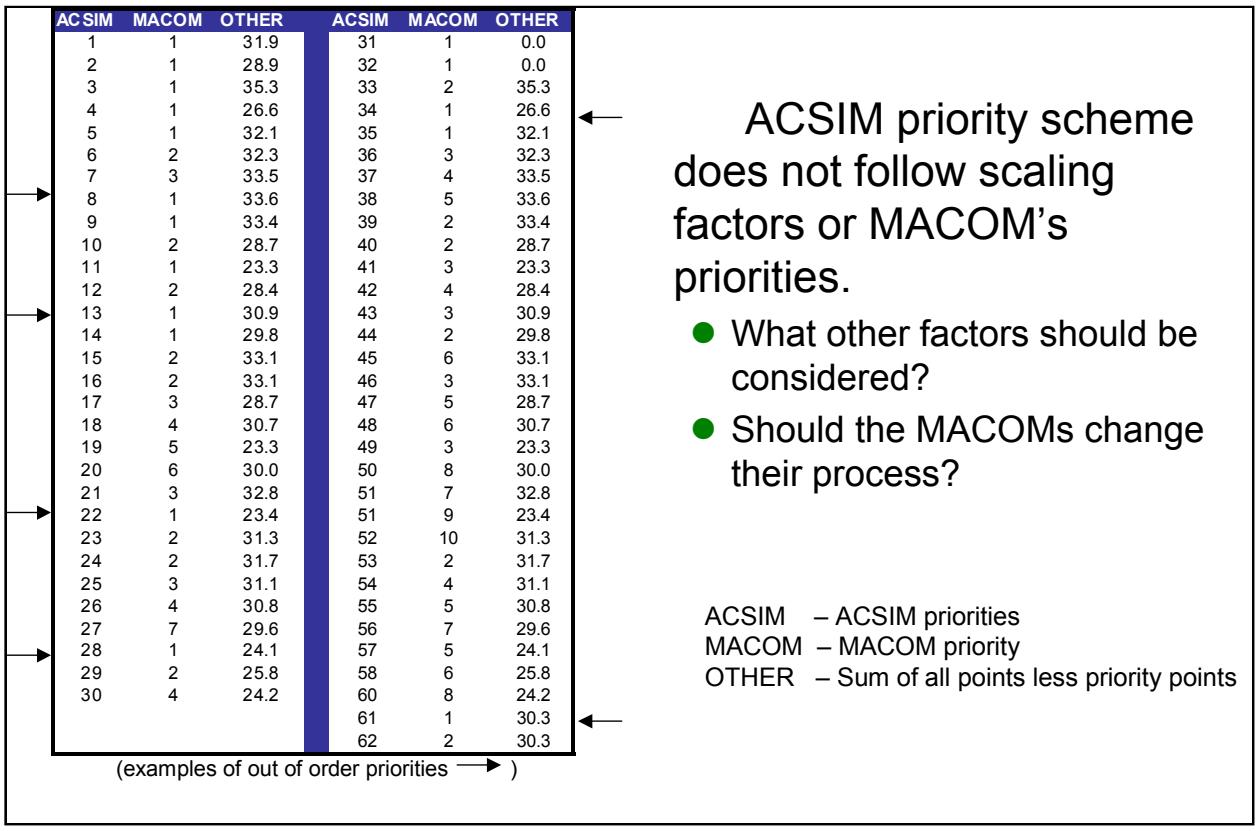
- With a SF = 7 the priority placement is approximately 78% with both the notional and proposed equations. (If we use the Air Force eq. we have 44%).
- With the proposed equation 21 projects change positions on the overall project list due to the PRV/POP factor and its impact on priority values.

Figure 9. New Process Example

The shaded MACOM names under the proposed equation columns have projects that are in different positions from the notional equation. Using the rank system for PRV/POP P factor, 21 projects are in different positions. We can see from the result that even though the P factor equates to some changes, there are projects with larger MACOMs that are not pushed up on the overall list due to the total score of the equations' other components. Additional projects would change positions if the P factor were increased or the SF were changed (both have similar impacts).

4.2 What is Missing from the Process?

Throughout this analysis, we have been limited to a few small changes in the proposed equation. If we look at ACSIM's overall ranking (Figure 10) of the MACOM projects, we can see that there are a considerable number of projects that are out of priority placement, which is much more evident than in either the proposed or revised equations. It is obvious from this ranking that there are other aspects of these projects that are not included in either equation, but that the ACSIM considered important during his evaluation.



ACSIM	MACOM	OTHER	ACSIM	MACOM	OTHER
1	1	31.9	31	1	0.0
2	1	28.9	32	1	0.0
3	1	35.3	33	2	35.3
4	1	26.6	34	1	26.6
5	1	32.1	35	1	32.1
6	2	32.3	36	3	32.3
7	3	33.5	37	4	33.5
8	1	33.6	38	5	33.6
9	1	33.4	39	2	33.4
10	2	28.7	40	2	28.7
11	1	23.3	41	3	23.3
12	2	28.4	42	4	28.4
13	1	30.9	43	3	30.9
14	1	29.8	44	2	29.8
15	2	33.1	45	6	33.1
16	2	33.1	46	3	33.1
17	3	28.7	47	5	28.7
18	4	30.7	48	6	30.7
19	5	23.3	49	3	23.3
20	6	30.0	50	8	30.0
21	3	32.8	51	7	32.8
22	1	23.4	51	9	23.4
23	2	31.3	52	10	31.3
24	2	31.7	53	2	31.7
25	3	31.1	54	4	31.1
26	4	30.8	55	5	30.8
27	7	29.6	56	7	29.6
28	1	24.1	57	5	24.1
29	2	25.8	58	6	25.8
30	4	24.2	60	8	24.2
			61	1	30.3
			62	2	30.3

Figure 10. What is Missing from the Process?

The Naval Postgraduate School's long-term prioritization effort will attempt to quantify these other issues that are evident in the ACSIM evaluation and not in the current equations. For example, a DSS that includes environmental, schedule, budget constraints, and/or project characteristics may offer a more robust process.

One reason for ACSIM to increase the priority placement of a project is the ISR score. Numerous projects that are lower priority are placed before other higher priority projects due to a "C-4" ISR rating. It makes sense that a C-4 mission ISR rating be completed before a C-1 mission rating project. This phenomenon is captured in the ACSIM's proposed and the revised equations. One long-term goal is to further refine the ISR component (evaluate scores) and develop other factors that influence priority placement.

5 FINDINGS

The following represent the key findings for this analysis:

(1) The ACSIM's proposed equation can be improved (include a factor to distinguish MACOMs) with a PRV/POP factor. The P factor adds another dimension to the equation by including MACOM size characteristics in their MP scores.

(2) The equation that the Air Force uses to determine their MILCON priority does not capture population impacts.

(3) Scaling factors > 6 provide the most consistent prioritization. Consistent in this sense equates to priority placement. At SF values >> 6, the difference in priority scores is so large that the other equation components are consistently overcome by this one factor; therefore, SF should remain <6 to maintain value of all equation components. (At a value of 6, the difference between priority 1 and 2 is 6 points if P is not used.)

(4) The prioritization equation does not capture all elements that influence MILCON decisions and should be examined in detail (long-term project with NPS). There are project characteristics that the current equations do not address. The long-term effort should identify these possibilities and include them in a decision support system for ACSIM.

(5) The spreadsheet tool allows a quick data analysis of all equation parameters. The spreadsheet tool is a simple way to examine the influence of different equations and their components.

5.1 Recommendations

(1) In the short term:

- Add a P factor to the notional scheme.
- Use the following equation: **Project score = C + (1+P)*SF * (1-MACOM Priority) + ISR + PRB + IPT.**
- Use the following components: **Installation Status Report (ISR) – Maximum Values, PRB – Minimum Values, MACOM Team Assessment (IPT) – Minimum Values.**

(2) Long-term effort:

- Develop a decision support system that will assist ACSIM in examining priorities and developing the Army's MILCON priority list. Include costs, MILCON project status, budget constraints, and other project characteristics as developed by the student and approved by ACSIM.
- Sponsor an NPS graduate student to complete the project (CAA will assist, monitor, and provide required support; Dr. Rob Dell will be the student's advisor). Project is ongoing, with an expected completion date of June 2002.

(THIS PAGE INTENTIONALLY LEFT BLANK)

APPENDIX A PROJECT CONTRIBUTORS

1. PROJECT TEAM

a. Project Director

LTC William Tarantino, Resource Analysis Division

b. Other Contributor

Ms. Tina H. Davis, Publications Center

2. PRODUCT REVIEWERS

Dr. Ralph Johnson, Quality Assurance
Ms. Nancy M. Lawrence, Publications Center

3. EXTERNAL CONTRIBUTORS

Ms. Dorothy Sugiyama, DAIM-FDC
Mr. Pete Tamilin, DAIM-FDC
CPT James D Dzwonchyk, Naval Postgraduate School
Dr. Robert Dell, Naval Postgraduate School

(THIS PAGE INTENTIONALLY LEFT BLANK)

APPENDIX B REQUEST FOR ANALYTICAL SUPPORT

PART 1

Performing Division: RA ***Account Number:*** **2001194**

Tasking: Verbal ***Mode (Contract-Yes/No):*** No

Acronym: **PAM**

Title: Prioritizing Army MILCON

Start Date: 08-Aug-01 ***Estimated Completion Date:*** 03-Oct-01

Requestor/Sponsor (i.e., DCSOPS): ACSIM ***Sponsor Division:*** FDC

Resource Estimates: ***a. Estimated PSM:*** 1 ***b. Estimated Funds:*** $0.00

c. Models to be Used: **none**

Description/Abstract: The ACSIM has a system that prioritizes the Army's yearly MILCON requirements for funding purposes. CAA will review the existing system and recommend short-term improvements (for FY01) and possible approaches for long term improvements in the prioritization process. Short-term improvements have to be implemented within the bounds of the current system. Long term alternatives have to include a decision support system that maintains priority placement amongst MACOM priority projects, is easily updated, analytically defendable, and provides what-if analytical capability.

Study Director/POC Signature: ***Phone#:*** 703-806-5446

Study Director/POC: **LTC William Tarantino**

If this Request is for an External Project expected to consume 6 PSM or more, Part 2 Information is Not Required. See Chap 3 of the Project Directors' Guide for preparation of a Formal Project Directive.

PART 2

Background:

Scope:

Issues:

Milestones:

Signatures ***Division Chief Signature: ORIGINAL SIGNED AND DATED*** ***Date:***

Division Chief Concurrence: ORIGINAL SIGNED AND DATED

Sponsor Signature: ORIGINAL SIGNED AND DATED ***Date:***

Sponsor Concurrence (COL/DA Div Chief/GO/SE): ORIGINAL SIGNED AND DATED

(THIS PAGE INTENTIONALLY LEFT BLANK)